HOW THE ALTERATION OF A THIN WALL FOR S-S' DI QUARK PAIRS SIGNIFIES AN EINSTEIN CONSTANT DOMINATED COSMOLOGY AND THE BREAK DOWN OF SEMI CLASSICAL APPROXIMATIONS FOR INFLATION

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I. SETTING UP HOW TO ANALYZE PHYSICAL STATES IN THE PRECURSORS TO INFLATIONARY COSMOLOGY

Definition of what constitutes a semi classical state. As visualized by Buniy and Hsu of the Institute of Theoretical Science at the U. of Oregon, it is of the form $|a\rangle$

1) Assume $\langle a|1|a\rangle = 1$

(2) We assume that $|a\rangle$ is a state whose probability distribution is peaked about a central value, in a particular basis, defined by an operator Z

2a) Our assumption above will naturally lead, ***for some*** *n* values

$$\langle a|Z^n|a\rangle \equiv \left(\langle a|Z|a\rangle\right)^n \tag{1}$$

Let me now review in total what was done earlier for a model of S-S' pair nucleosynthesis, for di quark pair states in an early universe model. First of all will be the issue of how the potential evolved, namely:

$$\begin{array}{lll} V_1 & \to V_2 & \to V_3 \\ \phi(increase) \le 2\cdot\pi & \to \phi(decrease) \le 2\cdot\pi & \to \phi \approx \varepsilon^{+} \\ t \le t_P & \to t \ge t_P + \delta\cdot t & \to t >> t_P \end{array} \tag{2}$$

The potentials V_1, V_2, and V_3 will be described in terms of **S-S'** di quark pairs nucleating and then contributing to a chaotic inflationary scalar potential system.

$$V_1(\phi) = \frac{M_P^2}{2}\cdot(1-\cos(\phi)) + \frac{m^2}{2}\cdot\left(\phi-\phi^*\right)^2 \tag{3a}$$

$$V_2(\phi) \approx \frac{(1/2)\cdot m^2\phi^2}{(1 + A\cdot\phi^3)} \tag{3b}$$

$$V_3(\phi) \approx (1/2)\cdot m^2\phi^2 \tag{3c}$$

We should note that what is in Eq (3a) is a measure of the onset of quantum fluctuations

$$\phi^* \equiv \left(\frac{3}{16\cdot\pi}\right)^{\frac{1}{4}} \cdot \frac{M_P^{3/2}}{m^{\frac{1}{2}}} \cdot M_P \to \left(\frac{3}{16\cdot\pi}\right)^{\frac{1}{4}} \cdot \frac{1}{m^{\frac{1}{2}}} \tag{3d}$$

This should be seen in the context of the fluctuations having an upper bound specified by

$$\tilde{\phi}_0 > \sqrt{\frac{60}{2\cdot\pi}} M_P \approx 3.1 M_P \tag{3e}$$

Also, the fluctuations Guth had in mind were modeled via

$$\phi \equiv \tilde{\phi}_0 - \frac{m}{\sqrt{12\cdot\pi\cdot G}} \cdot t \tag{3f}$$

This is for his chaotic inflation model using his potential; I call the 3rd potential in Eq (3c)

Let us now view a toy problem involving use of a S-S' pair which we may write as

$$\phi \equiv \pi\cdot\left[\tanh b(x - x_a) + \tanh b(x_b - x)\right] \tag{4}$$

We can, in this give an approximate wave function as given by:

$$\psi \cong c_1 \cdot \exp(-\tilde{\alpha}\cdot\phi(x)) \tag{5}$$

Then we can look at if we have

$$\left(\int_{x_a}^{x_b} \psi\cdot V_i\cdot\psi\cdot 4\pi\cdot x^2\cdot dx\right)^N \equiv \left.\int_{x_a}^{x_b} \psi\cdot[V_i]^N\cdot\psi\cdot 4\cdot\pi\cdot x^2\cdot dx\right|_{i=1,2,3} \tag{6}$$

Assuming that this is a valid initial dimensional approximation, we did the following for the three potentials.

a. Assumed that the scalar wave functional term was decreasing in '*height*' and increasing in '*width*' as we moved from the 1st to the 3rd potentials. ϕ also had a definite evolution of the domain wall from a '*near perfect*' thin wall approximation to one which had a considerable slope existing with respect to the wall.

b. We also observed that there was a diminishing of applicability of eqn **6** for large *N* values, In doing to, we also noted that even in eqn **6** for the 1st potential, where eqn **6** was almost identically the same values on both sides of the inequality, that eqn **6** had diminishing applicability as a result for decreasing *b* values in eqn **4** which corresponded to when the thin wall approximation was least adhered to.

We also observed that for the third potential, that there was never any overlap in value between the left and right hand sides of eqn. **6** above,

c. Chaotic inflation in cosmology is in the sense portrayed by Guth with a quartic potential is a general term for models of the very early Universe which involve a short period of extremely rapid (exponential) expansion, blowing the size of what is now the observable Universe up from a region far smaller than a proton to about the size of a grapefruit (or even bigger) in a small fraction of a second. The relative good fit of eqn **6** above for the first two potentials is in itself a good argument that the thin wall approximation breaks down past the point of baryogenesis after the chaotic inflationary regime is initiated by the 3rd potential as modeled by Guth[4]

I wish to present a new paradigm as to how topological defects (kinks and anti kinks) contribute to the onset of initial conditions at the beginning of inflationary cosmology.

0th, that a C-P violation in initial states would lead to an initial Baryon condensate of matter separating into actual di quark (**S-S'**) pairs leading to:

1st ,that for times less than or equal to Planck time t_P the potential system for analyzing the nucleation of a universe is a driven Sine Gordon system with the driving force in magnitude far less than the overall classical Sine Gordon potential.

2nd premise lies in having topological charges for a soliton – anti soliton di quark pair $(S - S')$ stem prior to Planck time t_P for this potential system cancel out, leaving a potential proportional to ϕ^2 minus a contribution due to quantum fluctuations of a scalar field being equal in magnitude to a classical system, with the remaining scalar potential field contributing to cosmic inflation in the history of the early universe. The **3rd** assumption is that a vacuum fluctuation of energy equivalent to $\Delta t \cdot \Delta E = \hbar$ will lead to the nucleation of a new universe, provided that we are setting our initial time $t_P \approx \Delta t$ as the smallest amount of time which can be ascertained in a quantum universe.

II. INCLUDING IN NECESSARY AND SUFFICIENT CONDITIONS FOR FORMING A CONDENSATE STATE AT OR BEFORE A GIVEN PLANCK TIME t_P

We look at Ariel Zhitnitsky's formulation of how to form a condensate of a stable soliton style configuration of cold dark matter as a starting point for how an axion field can initiate forming a so called QCD ball. This ball could in fact be the template for the initial expansion of a scalar field leading to false vacuum inflationary dynamics in the expansion of the universe. Zhitnitsky's formulation uses quarks in a non hadronic state of matter, but which in the beginning can be in di quark pairs. In doing so, Zhitnitsky's calculations for quarks being squeezed by a so called QCD phase transition due to the violent collapse of an axion domain wall should be used. The axion domain wall would be the squeezer to obtain a soliton (anti soliton) configuration. This pre supposes

$$M_B \approx B^{8/9} \tag{7}$$

And, Zhitnitsky further gives a criteria for absolute stability by writing a region of stability for the QCD balls dependent upon the inequality occurring for $B. > B_C$ (a critical charge value)

$$m_N > \frac{\partial M_B}{\partial B} \tag{8}$$

He furthermore states that stability, albeit not absolute stability is still guaranteed with

$$1 << B < B_C \tag{9}$$

If there is a balance between Fermi pressure P_f and a pressure due to surface tension, with σ being an axion wall tension value so that

$$\left(P_\sigma \cong \frac{2\sigma}{R}\right) \equiv \left(P_f \cong -\frac{\Omega}{V}\right) \tag{10}$$

This pre supposes that Ω is some sort of thermodynamic potential of a non interacting Fermi gas, when assuming $\tilde{c} \approx .7$, and also setting $B \approx B_C \propto 10^{+33}$ so that

$$R \equiv R_0 \cong \left(\frac{\tilde{c} \cdot B^{4/3}}{8 \cdot \pi \cdot \sigma}\right)^{1/3} \tag{11}$$

If we wish to have this of the order of magnitude of a Planck length l_P, then the axion domain wall tension must be huge. And a minimum value of B which Zhitnitsky set as

$$B_C^{\exp} \sim 10^{20} \tag{12}$$

III. HOW THIS TIES IN WITH REGARDS TO THE SCHERRER K ESSENCE MODEL RESULTS

We have investigated the role an initial false vacuum procedure with a driven sine Gordon potential plays in the nucleation of a scalar field in inflationary cosmology. Here, we show how that same scalar field blends naturally into the chaotic inflationary cosmology presented by Guth which has its origins in the evolution of nucleation of an electron-positron pair in a de Sitter cosmology. The final results of this model, when $\phi \to \varepsilon^+$, appears congruent with the existence of a region that matches the flat slow roll requirement of $\left|\frac{\partial^2 V}{\partial \phi^2}\right| << H^2$; where H is the expansion rate that is a requirement of realistic inflation models. This is due to having the potential in question $V \propto \phi^2 \xrightarrow[\phi \to \varepsilon^+]{} V_0 \equiv$ constant for declining scalar values.

IV. HOW DARK MATTER TIES IN, USING PURE KINETIC K ESSENCE AS DARK MATTER TEMPLATE FOR A NEAR THIN WALL APPROXIMATION OF THE DOMAIN WALL FOR ϕ

We define k essence as any scalar field with non-canonical kinetic terms. Following Scherrer,[13] we introduce a momentum expression via

$$p = V(\phi) \cdot F(X) \tag{13}$$

where we define the potential in the manner we have stated for our simulation as well as set[13]

$$X = \frac{1}{2} \cdot \nabla_{\mu}\phi \quad \nabla^{\mu}\phi \tag{14}$$

and use a way to present *F* expanded about its minimum and maximum[13]

$$F = F_0 + F_2 \cdot (X - X_0)^2 \tag{15}$$

where we define X_0 via $F_X \big|_{X=X_0} = \left.\frac{dF}{dX}\right|_{X=X_0} = 0$, as well as use a density function

$$\rho \equiv V(\phi) \cdot \left[2 \cdot X \cdot F_X - F \right] \tag{16}$$

where we find that the potential neatly cancels out of the given equation of state so

$$w \equiv \frac{p}{\rho} \equiv \frac{F}{2 \cdot X \cdot F_X - F} \tag{17}$$

as well as a growth of density perturbations terms

$$C_x^2 = \frac{(\partial p / \partial X)}{(\partial \rho / \partial X)} \equiv \frac{F_X}{F_X + 2 \cdot X \cdot F_{XX}} \tag{18}$$

where $F_{XX} \equiv d^2 F / dX^2$, and, we pick a value of X close to an extremal value of X_0.

$$X = X_0 + \tilde{\varepsilon}_0 \tag{19}$$

$$\left(F_X + 2\cdot X \cdot F_{XX}\right)\cdot \ddot{\phi} + 3\cdot H \cdot F_X \cdot \dot{\phi} \cong 0 \tag{20}$$

which may be re written as

$$\left(F_X + 2\cdot X \cdot F_{XX}\right)\cdot \ddot{X} + 3\cdot H \cdot F_X \cdot \dot{X} \cong 0 \tag{21}$$

This means that we have a very small value for the growth of density perturbations

$$C_S^2 \cong \frac{1}{1+2\cdot\left(X_0 + \tilde{\varepsilon}_0\right)\cdot\left(1/\tilde{\varepsilon}_0\right)} \equiv \frac{1}{1+2\cdot\left(1+\dfrac{X_0}{\cdot\tilde{\varepsilon}_0}\right)} \tag{22}$$

when we can approximate the *kinetic energy* from

$$\left(\partial_\mu \phi\right)\cdot\left(\partial^\mu \phi\right) \equiv \left(\frac{1}{c}\cdot\frac{\partial\phi}{\partial\cdot t}\right)^2 - \left(\nabla\phi\right)^2 \cong -\left(\nabla\phi\right)^2 \to -\left(\frac{d}{dx}\phi\right)^2 \tag{23a}$$

So, $\left|X_0\right| \approx \frac{1}{2}\cdot\left(\frac{\partial\phi}{\partial x}\right)^2 >> \tilde{\varepsilon}_0$ (23b)

$$0 \le C_S^2 \approx \varepsilon^+ << 1 \tag{24}$$

and

$$w \equiv \frac{p}{\rho} \cong \frac{-1}{1-4\cdot\left(X_0 + \tilde{\varepsilon}_0\right)\cdot\left(\dfrac{F_2}{F_0 + F_2\cdot\left(\tilde{\varepsilon}_0\right)^2}\cdot\tilde{\varepsilon}_0\right)} \approx 0 \tag{25}$$

We get these values for the phase ϕ being nearly a box, therefore $w \equiv \frac{p}{\rho} \cong 0 \Rightarrow$ treating the potential system given by the 1st potential (modified sine Gordon with small quantum mechanical driving term added) as a semi classical system obeying eqn **6** above.

When we observed $\left|X_0\right| \approx \frac{1}{2}\cdot\left(\frac{\partial\phi}{\partial x}\right)^2 \cong \frac{1}{2}\left[\delta_n^2\left(x+L/2\right)+\delta_n^2\left(x-L/2\right)\right]$ (26)

with

$$\delta_n\left(x \pm L/2\right) \xrightarrow[n\to\infty]{} \delta\left(x \pm L/2\right) \tag{27}$$

as the slope of the **S-S'** pair approaches a box wall approximation in line with thin wall nucleation of **S-S'** pairs being in tandem with $b \to$ *larger*.; this could lead to an unphysical situation with respect to delta functions giving infinite values of infinity, which would force both C_s^2 and $w \equiv \frac{p}{\rho}$ to be zero for $\left|X \approx X_0\right| \cong \frac{1}{2}\cdot\left(\frac{\partial\phi}{\partial x}\right)^2 \to \infty$ if the ensemble of **S-S'** pairs were represented by a pure thin wall approximation. If we adhere to a finite steep slope convention to modeling both C_s^2 and $w \equiv \frac{p}{\rho}$, we get:

When $b \geq 10$

$$w \cong \frac{-1}{1-4\cdot\frac{X_0\cdot\tilde{\varepsilon}_0}{F_2}} \to -1 \tag{28}$$

and recover Sherrer's solution for the speed of sound

$$C_S^2 \approx \frac{1}{1+4\cdot X_0\left(1+\frac{X_0}{2\cdot\tilde{\varepsilon}_0}\right)} \to 0 \tag{29}$$

(If an example $F_2 \to 10^3$, $\tilde{\varepsilon}_0 \to 10^{-2}$, $X_0 \to 10^3$). Similarly, if $b \to 3$ in Eq. **4** above

$$w \cong \frac{-1}{1-4\cdot\frac{X_0\cdot\tilde{\varepsilon}_0}{F_2}} \to -1 \tag{30}$$

and

$$C_S^2 \approx \frac{1}{1+4\cdot X_0\left(1+\frac{X_0}{2\cdot\tilde{\varepsilon}_0}\right)} \to 1 \tag{31}$$

if $F_2 \to 10^3$, $\tilde{\varepsilon}_0 \to 10^{-2}$. Furthermore $\left|X_0\right| \to$ *a small value*, which for $b \to 3$ in Eq. (4) would lead to $C_S^2 \approx 1$, This eliminates having to represent the initial state as behaving like pure radiation state (as Cardone postulated), i.e., we then recover the cosmological constant. When $\left|X_0\right| \approx \frac{1}{2}\cdot\left(\frac{\partial\phi}{\partial x}\right)^2 >> \tilde{\varepsilon}_0$ no longer holds, we can have a hierarchy of evolution of the universe as being first radiation dominated, then dark matter, and finally dark energy.

If $\left|X \approx X_0\right| \cong \frac{1}{2}\cdot\left(\frac{\partial\phi}{\partial x}\right)^2 \to \infty$, neither limit leads to a physical simulation that makes sense;. We furthermore have, even with $w = -1$

$$C_s^2 \equiv 1 \xrightarrow[b1\to3]{} 1 \tag{32}$$

indicating that the evolution of the magnitude of the phase $\phi \to \varepsilon^+$ corresponds with a reduction of our cosmology from a dark energy dark matter mix to the more standard cosmological constant models used in astrophysics.

V. CONCLUSION

Veneziano’s model gives us a neat prescription of the existence of a Planck’s length dimensionality for the initial starting point for the universe via:

$$l_P^2 / \lambda_S^2 \approx \alpha_{GAUGE} \approx e^{\phi} \quad (33)$$

where the weak coupling region would correspond to where $\phi << -1$ and λ_S is a so called quanta of length , and $l_P \equiv c \cdot t_P \sim 10^{-33} cm$. As Veneziano implies by his 2nd figure [2] , a so called scalar dilaton field with these constraints would have behavior seen by the right hand side of his figure one, with the $V(\phi) \to \varepsilon^{+}$ but would have no guaranteed false minimum $\phi \to \phi_F < \phi_T$ and no $V(\phi_T) < V(\phi_F)$. The typical string models assume that we have a present equilibrium position in line with strong coupling corresponding to $V(\phi) \to V(\phi_T) \approx \varepsilon^{+}$ but no model corresponding to potential barrier penetration from a false vacuum state to a true vacuum in line with Coleman's presentation

FINAL POINT TO KEEP IN MIND IN ALL OF THIS.

We find that the above formulation in equation **33** is most easily accompanied by the given **S-S'** di quark pair basis for the scalar field built up in this paper, and that it also is consistent with the initial scalar cosmological state evolving toward the dynamics of the cosmological constant via the *k* essence argument Furthermore, we also argue that the semi classical analysis of the initial potential system as given by eqn **6** above and its subsequent collapse is de facto evidence for a phase transition to conditions allowing for CMB to be created at the beginning of inflationary cosmology.

It is important to note that this material has been blended into a white paper discussion of finding traces of dark energy, with respect to the big bang in CMB radiation. An arXIV entry I wrote, which blends some of this same material into a discussion of data reconstruction which has been used in the DETF science discussions of dark energy searches. For those who would like to peruse what was done, in this endeavor, I would recommend that they view the following. This gives much of the material which was in a white paper accepted by the DETF committee headed by Dr. Kolb

PHYSICS, ABSTRACT
PHYSICS/0510039

From: Andrew Beckwith [view email]
Date: Tue, 4 Oct 2005 21:27:12 GMT (264kb)

How soliton- anti soliton di quark pairs signify an Einstein constant dominated cosmology and facilitate reconstruction of initial dark matter contributions to CMB

Authors: A.W.Beckwith
Categories: physics.gen-ph
Comments: 38 pages, 3 figures. Contains material of a white paper proposal accepted in June 28, 2005, by the DETF committee headed by Dr. Edward Kolb to review science requirements for a dark energy mission. Combines both a submitted white paper to that committee plus the analytical derivation of the potential suggested in the data reconstruction scheme of this document
Subj-class: General Physics

ABSTRACT

We review the results of a model of how nucleation of a new universe occurs, assuming a di quark identification for soliton-anti soliton constituent parts of a scalar field. The initial potential system employed is semi classical in nature, becoming non-classical at the end of chaotic inflation at the same time cosmological expansion is dominated by the Einstein cosmological constant. We use Scherrer's derivation of a sound speed being zero during initial inflationary cosmology, and change it afterwards as the slope of the scalar field moves away from a thin wall approximation. All this is to aid in a data reconstruction problem of how to account for the initial origins of CMB due to dark matter since effective field theories as presently constructed require a cut off value for applicability of their potential structure. This is often at the cost of, especially in early universe theoretical models, of clearly defined baryogenesis, and of a well defined mechanism of phase transitions. The material below is now a proposal, in part accepted as a point of discussion as a white paper (appropriately) submitted to the Dark Energy Task Force, in its mission to advise (through its parent committees) the NSF, NASA and DOE. This was for helping to select both ground-based and space-based techniques for analyzing data as well as recommending the science requirements for a space-based dark energy mission.

Full-text: PDF only

This is an arXIV paper rendition of material pertinent to this topic, and relevant possible experimental implications of a proper search into verification of this nucleation scheme from experimental data.

FIGURE CAPTIONS

Fig 1a,b : Evolution of the phase from a thin wall approximation to a more nuanced thicker wall approximation with increasing L between S-S' instanton componets. The 'height' drops and the 'width' L increases corresponds to a de evolution of the thin wall approximation. This is in tandem with a collapse of an initial nucleating 'potential' system to the standard chaotic scalar ϕ^2 potential system of Guth.. As the 'hill' flattens, and the thin wall approximation dissipates, the physical system approaches standard cosmological constant behavior.

Fig 2a,b :As the *walls* of the ***S-S'*** pair approach the thin wall approximation , one finds that for a normalized distance $L = 9 \rightarrow$ ***L*** = 6 $\rightarrow L$ = 3 that one has an approach toward delta function behavior at the boundaries of the new, nucleating phase. As *L* increases, the delta function behavior subsides dramatically. Here, the $L = 9 \Leftrightarrow$ conditions approaching a cosmological constant. ***L***= 6 $\Leftrightarrow$ conditions reflecting Sherrer's dark energy – dark matter mix. L = 3 $\Leftrightarrow$ approaching unphysical delta function contributions due to a pure thin wall model.

Fig 3 Initial configuration of the domain wall nucleation potential as given by Eq. (4.4a) which we claim eventually becomes in sync with Eq. (3a) due to the phase transition alluded to by Dr. Edward Kolbs model of how the initial degrees of freedom declined from over 100 to something approaching what we see today in flat Euclidian space models of space time (i.e. the FRW metric used in standard cosmology)

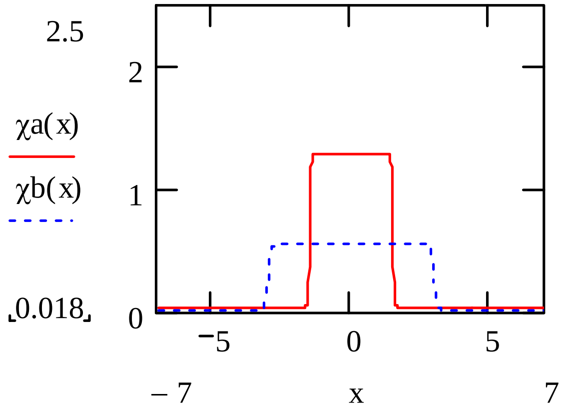

Figure 1a,b

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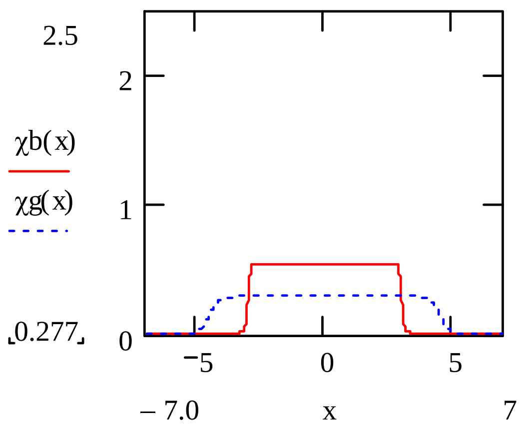

Figure 2a,b

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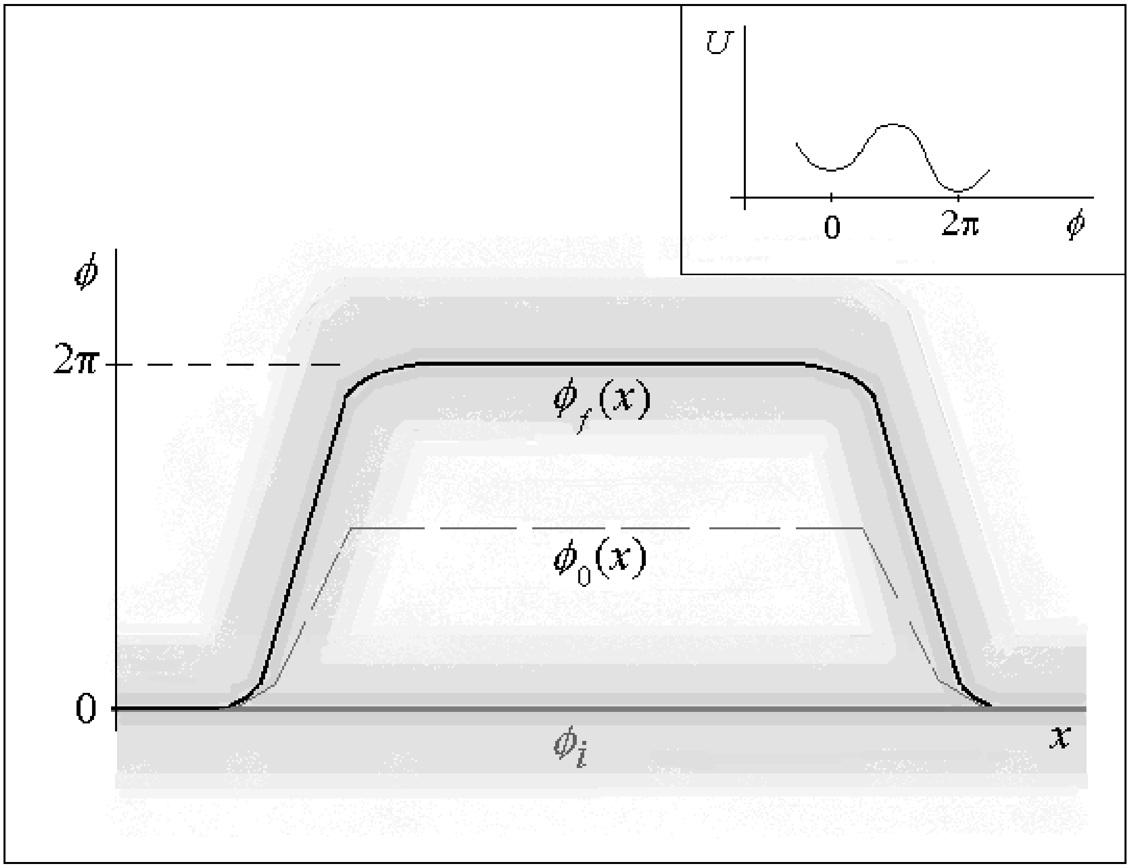

Figure 3

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